Report into

Completion of the Cairns Transmission Reinforcement

Powerlink Queensland
January 2000

1.0 EXECUTIVE SUMMARY

1.1 Background

In April 1996, Powerlink Queensland initiated, after joint planning and consultation with FNQEB (now Ergon Energy) in accordance with the Queensland Grid Code, a large multi-stage project to reinforce the transmission network into Cairns.

The project recognised the rapid growth in the area and the development of Cairns as a major international tourist destination with a need for secure and reliable electricity supply, despite its distance from the major power generation sources.

The project, also known as the Chalumbin-Woree project, was planned to be undertaken in stages so as to progressively meet the growth in electricity demand and spread the cost impacts on customers accordingly. The initial plan called for three stages (illustrated in Figure 1) as follows:

Stage 1 Construct the line between Woree (on the outskirts of Cairns) and Springmount (near Walkamin and part of the way to the main 275kV substation at Chalumbin), and operate it initially at 132kV. This stage – through the environmentally sensitive World Heritage-listed rainforest – was completed in June 1998 at a cost of $58.5M.

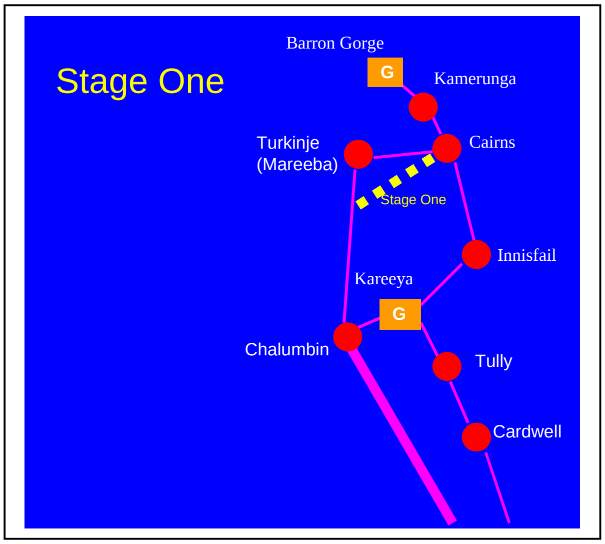
Stage 2 Complete the 275kV line from Springmount to Chalumbin, and operate the entire link at 132kV. This was originally planned for October 2001.

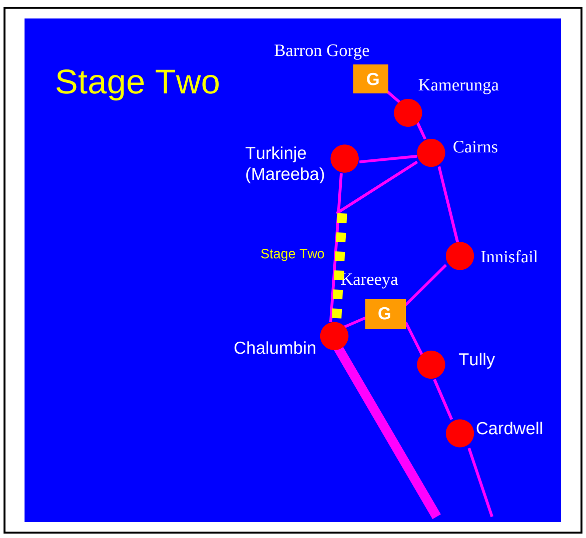
Stage 3 Establish the new Woree substation, and uprate the Chalumbin-Woree line to 275kV. This was originally planned for 2005.

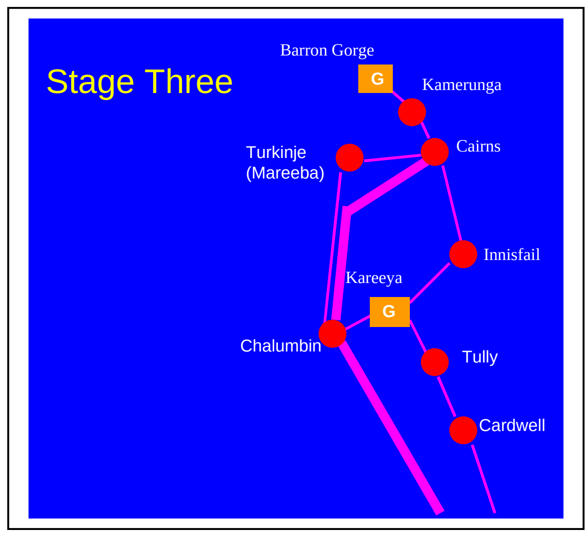
Powerlink is now reassessing the scope and timing of Stage 2, as recent planning studies by Powerlink Queensland and FNQEB (now Ergon Energy) identified that the electricity system supplying Cairns in Far North Queensland will reach its technical limits in the near future. Reassessment is also necessary in the light of the changing circumstances since the 1996 plan. These circumstances include changes to the load forecast, the emergence of some local generation, and the performance of the existing transmission network.

The National Electricity Market has also commenced since the 1996 plan. It is debatable whether the later stages of an already commenced project such as this should be subjected to the (fluid) processes under the National Electricity Code for new transmission investments. However, Powerlink always carefully analyses its investment decisions, to ensure that the investment is prudent. This analysis necessarily involves discussions with affected parties and those who are able to provide alternatives which could reduce the scope and/or change the timing of the proposed transmission investment, and due consideration of such alternatives. Information emerging from those discussions and considerations has been included in this report, along with a summary of the technical analysis carried out by Powerlink.

Figure 1:







1.2 Conclusions and Recommendations

The report contains the following conclusions:

- In order to maintain appropriate levels of system security and reliability, augmentation is required prior to the summer of 2002/03.
- The 1996 plan for Stage 2 of the Cairns reinforcement should be slightly modified, to better meet the security and reliability criteria and maximise the benefits to customers.
- The recommended modification involves completion of the link between Chalumbin and Springmount, with operation of one circuit at 132kV and the other as a 275kV 300MVA transformer ended feeder.

- The estimated capital cost for (the modified) Stage 2 is $44M. This translates into an annual cost allocation to customers (via the local distribution corporations) of approximately $4.4M.

- Stage 2 should be completed by October 2002 (rather than 2001 as per the 1996 plan). The main contributors to this deferral have been a lower projected load growth and the development of (limited) local generation in the Cairns area. The recommended 2002/03 timing requires a firm commitment to the investment by February 2000.

- The final stage (Stage 3) of the project, uprating the second circuit to 275kV capability, is expected to still be required by the summer of 2005/06 as per the initial 1996 plan, but timing is dependent on load growth in the region.

- Whilst the primary benefit is increased reliability and continued ability to supply all load during single contingencies, the modified Stage 2 will also reduce energy lost during transmission. This alone is a significant benefit, representing a saving for customers of approximately $2M per annum.

- The recommendation will ensure Powerlink meets its network reliability and security obligations.

1.3 Feedback from Affected Customers

In relation to the above recommendations, the affected customer, Ergon Energy, has advised that:

1. it supports the need for the augmentation and the scope of the recommended option
2. it is concerned about the risks ahead of the recommended implementation timing of 2002/03, and
   (a) encourages Powerlink to seek greater certainty from Stanwell Corporation regarding the availability of Barron Gorge Power Station during critical periods
   (b) encourages Powerlink to seek ways to advance construction of the project and/or implement other measures if sufficient certainty regarding generation output from Barron Gorge is not achievable.

Powerlink Queensland has agreed to address these concerns as part of its implementation plan for the project. It may be feasible for Powerlink to manage the project implementation to allow at least one circuit of the new line between Chalumbin and Springmount to be operational at 132kV prior to the 2001/02 summer.

None of the other entities consulted raised concerns about Powerlink's recommendation.

2.0 NEED FOR REINFORCEMENT

The 1996 plan for a 3-stage reinforcement recognised the development of Cairns as a major international tourist destination as well as the administrative hub for Far North Queensland. Powerlink's analysis shows that, without augmentation, the relevant technical limits of the transmission system supplying the Cairns area[1] will soon be exceeded, thereby resulting in unacceptable levels of electricity system security and supply reliability.

These future limitations of the existing electricity system will arise due to the combination of three factors:

(a) Strong Growth in Demand - Electricity demand in the area has been growing at very high annual rates of up to 8% per year. While growth has slowed since the projections used to develop the 1996 plan, electricity demand is still forecast to grow by about 5% per year over the next five years, equivalent to about 10 MW per year.

(b) Limits on Existing Transmission System - Existing transmission lines into the Cairns area are operating at or near capacity (ie - near technical limits for thermal rating of the aged Innisfail-Cairns 132kV line and reactive/voltage control considerations).

(c) Limits on Existing Generation Capacity - Barron Gorge hydro-electric power station is the only generator within the immediate Cairns area[2] that produces power during the peak summer period. The registered capacity of Barron Gorge is 60MW, but limited water supply allows full output only during the wet season (January to March) or for short periods such as system emergencies. During a typical summer day, there is usually only sufficient water for one unit to provide up to 15MW, while the other unit generates reactive power (for voltage support) only[3].

Over time, load growth and the above limitations will combine to reduce the reliability of the electricity supply to Cairns. The key risk is that electricity demand will exceed the reliable supply capability of the existing system (see Figures 2 and 3). A secondary risk is that, due to insufficient spare capacity, Powerlink will be unable to take existing transmission plant out of service to carry out safe plant maintenance.

A detailed discussion of the optimum timing is contained in Section 3.0. However, the clear conclusion is that, in the near future, standard reliability planning criteria (n-1) will not be met without action to increase the capability of the existing system - that is,

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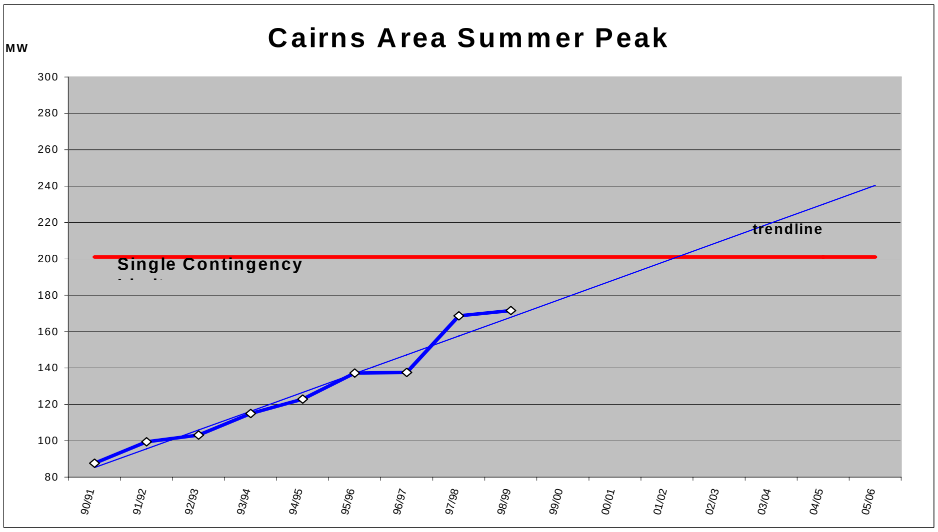
[1] The Cairns area is defined as the customers served by Ergon Energy's Cairns City substation and Powerlink's Cairns (Hartley Street), and Kamerunga substations. This broadly translates to a geographic area north of a line from Atherton to Babinda, and east of a line from Atherton to Mareeba and Port Douglas (see system diagram in Appendix 1).

[2] The wind farm at Windy Hill and the Tablelands Sugar Mill are outside the area where they would make a direct contribution to meeting the needs of Cairns area electricity customers.

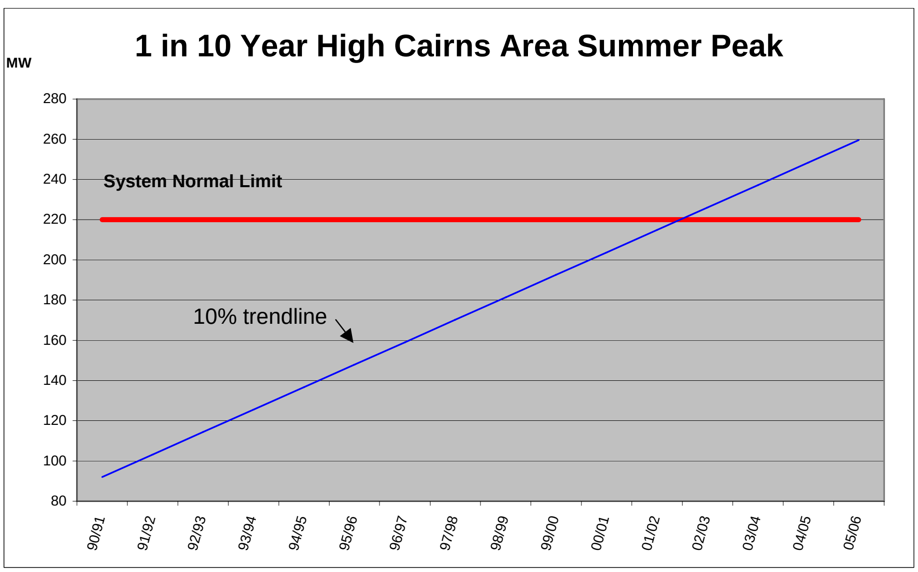
[3] See discussion of risks, sensitivities and implications of Barron Gorge Power Station output in 3.0

Powerlink's transmission system will be unable to meet all load during single faults or contingencies. The result will be an increasing risk of loss of supply to customers.

<u>Figure 2 – Single Contingency Limit & Actual Demand</u>



<u>Figure 3 – Adverse Weather & System Normal Limit</u>



<u>Note:</u> Figure 2 shows actual demand and resulting trendline. Figure 3 uses Powerlink's trendline 1 Year in 10 peak demand forecast (ie 10% probability of occurring). An output of 15MW has been assumed for Barron Gorge Power Station, with the second unit operating as a synchronous compensator. All existing transmission and generation assets and demand side management initiatives are incorporated. No new electricity developments have been allowed for in the graphs, as none have been committed in the timeframe. Sensitivity to variations in these assumptions is covered in Section 3.0.

3.0 TIMING

This section examines the optimum timing for Stages 2 and 3 of the Cairns reinforcement. The optimum timing depends principally on load growth and consequent decline in system security and reliability over time.

Because the need is driven by security and reliability criteria, the prime consideration is the point in time at which the capability of the existing system will be exceeded if no action is taken. The individual costs and benefits of potential solutions - either Stage 2 of the Chalumbin-Woree project, demand side management or generation options - are only significant to the extent that potential solutions can meet the required timetable.

Of key importance in the timing decision are assumptions relating to:

- required reliability levels for Cairns, as a major international tourist destination and commercial hub
- meeting National Electricity Code technical requirements
- the conditions of Powerlink's transmission authority (see 3.2.1)
- estimated data such as load forecasts and the availability of local generation output during the critical summer peak period
- the level of risk for loss of electricity supply which Ergon Energy (and the Far North Queensland Electricity Council) is prepared to accept.

Powerlink's analysis uses a range of possible scenarios to demonstrate the implications of various timings. A summary of key results has been included in this report to facilitate the assessment of these risks.

3.1 PLANNING SCENARIOS

Seven credible scenarios based on a variety of assumptions about critical factors such as electricity demand growth, peak summer temperatures and generation output have been developed. While other combinations are theoretically possible, these seven scenarios demonstrate the key risks and implications associated with different augmentation timings.

For ease of understanding, Powerlink has described the scenarios according to economic growth and weather patterns:

TABLE 1:

Low Growth	Low economic growth and typical summer weather
Medium Growth	Medium economic growth and typical summer weather
High Growth	High economic growth and typical summer weather
Medium Growth; Dry Year	Medium economic growth and drought conditions
Medium Growth; Very Hot Year	Medium economic growth and extreme summer temperatures
Med. Growth; Very Hot & Dry Year	Medium economic growth, extreme summer temperatures and drought conditions
Low Growth & Dry Year	Low economic growth and drought conditions

Each scenario description corresponds to a combination of technical/quantitative assumptions used to analyse system capability:

TABLE 2:

	Forecast Year	Weather Sensitivity Forecast	Output Barron Gorge Power Station
Low Growth:	1998	1 Year in 2	15MW + 1 synch. comp
Medium Growth:	1997	1 Year in 2	15MW + 1 synch. comp
High Growth:	1996	1 Year in 2	15MW + 1 synch. comp
Medium Growth; Dry Year:	1997	1 Year in 2	2 synch. comp
Medium Growth; Very Hot Year:	1997	1 Year in 10	15MW + 1 synch. comp
Medium Growth; Very Hot & Dry Year:	1997	1 Year in 10	2 synch. comp
Low Growth & Dry Year:	1998	1 Year in 2	2 synch. comp

Economic Growth *Low Economic Growth = December 1998 Load Forecast*
Medium Economic Growth = December 1997 Load Forecast
High Economic Growth = December 1996 Load Forecast

All forecasts used are "Ten Year Outlook" peak summer load forecasts. This represents the maximum demand required to be met by the electricity system in the Cairns area. The most recent[4] December 1998 ten-year forecast is used to represent low economic growth, as the 1998 forecast was characterised by a pessimistic growth outlook associated with the downturn of Asian economies. The December 1997 ten-year forecast almost exactly corresponds to the historical trend of actual demand experienced over the past eight years. For this reason, it has been assigned the description of medium economic growth. It is important to note that the lower actual demand experienced in 1998/99 was a return to this historical trend from the level in the previous year which was above the trend (see Appendix 2). High economic growth within the scenarios is represented by the December 1996 forecast figures, as these were characterised by an optimistic growth outlook.

Weather Sensitivity/Summer Temperatures
Average summer temperatures = 1 Year in 2 Forecasts
Extreme summer temperatures = 1 Year in 10 Forecasts

It is standard Powerlink practice to develop two load forecast levels – one with a 50% probability of occurring (known as a 1 Year in 2 Forecast) and the other with a 10% probability of occurring (1 Year in 10 Forecast). In the past, augmentations have been planned based on the 50% forecast. However, it is important to be aware of the implications of extreme summer temperatures which have a 10% probability of occurring when examining the risks associated with timing decisions. The emergence of higher customer expectations of reliability (and the related desire to seek legal redress for outages) calls into question whether augmentation timing should be determined using the 50% (average weather) forecast.

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[4] The December 1999 forecast is expected to continue to show relatively low growth in electricity demand as economic recovery has not fully eventuated, and some sugar mill and wind generation has been added in Far North Queensland.

Rainfall Conditions
Average rainfall = 15MW+1 unit synchronous compensator at Barron Gorge
Drought conditions = only 2 units synchronous compensator at Barron Gorge

The Barron Gorge hydro-electric power station supplies power that would otherwise need to be transferred into Cairns via the transmission system. It is also able to provide voltage support during transmission line outages. Powerlink's planning approach is to assume 15MW output at Barron Gorge from one unit, with the other unit operating as a synchronous compensator[5]. This is supported by historical evidence and is thus used to represent average conditions. However, because it is a 'run of river' station with very little storage, the generated output of the Barron units depends heavily on water availability and may be significantly affected in drought conditions[6] [7]. To represent this risk, a higher risk scenario has been included – two units operating as synchronous compensators. It should be noted that this low probability risk has relatively serious consequences, but is not the worst case scenario – it is of course possible that extreme drought or a major plant outage could render one or both units *completely* unavailable during a critical peak demand period.

Powerlink has no information about the condition or likely future availability of the Barron Gorge generating units which would lead us to assume an average output level other than 15MW. However, the units were commissioned in 1963, and it is possible their availability may decline over time. In addition, Stanwell Corporation, the owner of Barron Gorge Power Station, operates the station according to its commercial requirements within the National Electricity Market. Stanwell has advised Powerlink, that due to the uncertainty in available water, Stanwell would be unable to enter into any agreement now for a guaranteed power output from Barron Gorge Power Station in the summers from 2001/02 onwards.

[5] Producing no power output - providing voltage support only
[6] Powerlink's historical rainfall records for January and February show a 3% probability (2 years in 67) of less than 5% capacity factor for Barron Gorge power station, and an 18% probability (12 years in 67) of less than 10% capacity factor during these months.
[7] The primary water source for Barron Gorge Power Station is water releases from Tinaroo Falls Dam, which is owned by the Department of Natural Resources and operated for upstream irrigation purposes. If drought conditions occur, water in Tinaroo Falls Dam is likely to be reserved for irrigation purposes and not be made available for electricity generation purposes. This means that electricity generation from Barron Gorge Power Station is totally dependent on erratic "run of river" streamflows and is largely outside the control of Stanwell Corporation. There is no obligation upon Stanwell or the Department of Natural Resources to support the power requirements of Cairns during system contingencies.

3.2 TIMING IMPLICATIONS

Any timing recommendation requires a balance of the risks associated with variations in electricity demand, temperature and generation output. This is clearly shown by the dates at which augmentation is required (ie – when peak demand will exceed secure supply capability of the existing system) under the seven scenarios outlined in Table 3.

TABLE 3: TIMING AT WHICH AUGMENTATION IS REQUIRED.

System Condition	Medium Growth & Weather	Dry Year	Very Hot Year	Very Hot & Dry Year	Low Growth	Low Growth & Dry Year	High Growth
N-1	2002/03	01/02	00/01	00/01	04/05	04/05	99/00
N-2	1992/93	91/92	92/93	91/92	92/93	91/92	92/93
System Normal	2003/04	02/03	02/03[8]	01/02	05/06	05/06	00/01

3.2.1. N-1 or N-2 Planning Criteria

In its recommendation at the end of this section, Powerlink concludes that it should plan its system in the Cairns region to meet standard planning criteria (ie – able to meet peak load with the worst single credible contingency, a criterion known as N-1).

Powerlink considers that 'N-1' is the appropriate criterion to use to meet the obligations of its transmission licence[9]. However, the National Electricity Code allows customers to enter into a contractual agreement with Powerlink for a higher or lower level of reliability.

In Table 3, a higher reliability is demonstrated by the N-2 criterion (ability to supply all peak load during a double contingency). 'System Normal' is considered the absolute minimum level of reliability required, and is defined as the ability to supply all load with all elements of the electricity system intact (ie – no faults or contingencies).

In cases where the probability of double contingencies is high (such as cases where double circuit faults are relatively frequent), N-2 may be a legitimate planning criterion. In the past, FNQEB (Ergon Energy) advised that planning for double circuit outages in the Far North was not appropriate. Although double circuit outages of the Chalumbin-Turkinje circuits have occurred relatively frequently, compared to transmission lines elsewhere in Queensland[10], the average duration has been only 0.8 minutes, with a maximum duration of six minutes over the past ten years.

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[8] Using 'System Normal' criteria, augmentation is required by 2002/03. This conclusion is reached using extreme demand, rather than average demand, forecasts. Powerlink's view is that average forecasts (with a 50% probability of being exceeded) are too risky for 'system normal' situations when all plant is in service.

[9] Powerlink's transmission authority includes a responsibility "… to ensure as far as technically and economically practicable, that the transmission grid is operated with enough capacity (and if necessary, augmented or extended to provide enough capacity) to provide network services to persons authorised to connect to the grid or take electricity from the grid." (Electricity Act 1994, S34.2).

[10] An average of 2.3 double circuit outages of this line have occurred each year over the past ten years, all during the peak summer period. This poor performance is attributed to the high lightning incidence in the area, and poor tower footing resistance. The results of a pilot study, and a subsequent decision to add an extra disc to all insulator strings and to improve footing resistances on the line, suggest line performance should considerably improve for the 1999-2000 summer.

FNQEB (Ergon Energy) previously considered the cost of developing a system able to withstand double contingencies exceeded the reliability benefit. Powerlink has not received contrary advice, and concludes it should continue to plan based on N-1. It is recognised that Cairns is a major international tourist centre, and this may, in the future, require higher levels of reliability.

3.2.2. Satisfying N-1 Criteria

Table 3 indicates that, based on N-1 reliability criteria, augmentation of the Cairns electricity system should occur by the summer of 2002/03 for the medium growth and average weather scenario. This is Powerlink's recommendation, but customers should be aware that, as shown in Table 3, it incorporates the following risks:

- if drought conditions OR extreme summer temperatures occur over the 2001/02 summer, Powerlink will be unable to supply all Cairns electricity demand during single contingencies.

- If drought conditions AND extreme summer temperatures are experienced during peak demand periods prior to augmentation in 2002/03, this has potentially serious implications. In the past, Powerlink has considered this a 'double contingency' in its planning approach because of its low probability. However, customers should be aware that Powerlink will be unable to meet N-1 requirements in 2000/01 under these conditions, with the potential for 83 hours of loadshedding *with all elements of plant in service* (see Table 4) in 2001/02.

- Another low probability, but nevertheless serious, risk exists if delays to augmentation occur (e.g. – heavy wet season during construction, etc). If augmentation is not in place by 2002/03 AND drought conditions or extreme summer temperatures are experienced in that year, Powerlink will be unable to meet all Cairns load for between 11 and 61 hours *with all elements of plant in service* (ie – system normal).

- If Cairns experiences a return to economic growth above the historical trend, N-1 conditions will not be met from all summers from 1999/2000 onwards until augmentation. This is considered a relatively low risk in the very short term.

Balancing these risks is the chance that the low growth scenarios will occur (ie – electricity demand will be lower than the historical trend). Based on these low growth scenarios, augmentation is not required until 2004/05.

It is Powerlink's view that, while lower growth over the next ten years is a credible scenario, the "balance of probabilities" makes it prudent to plan based on the historical trend. As noted, recent slowing of economic growth has resulted in actual demand *returning* to the historical trend. While growth may continue to slow (and cause demand to fall below the trendline), Powerlink considers the risk could be quite significant if augmentation is delayed and the demand in fact continues to follow the historical trend. This is particularly true given that there is already a degree of risk management inherent in the 2002/03 recommendation.

3.2.3. <u>Risks of Planning Using the Low Growth Scenarios</u>

To demonstrate and quantify the risks of delaying augmentation of the Cairns electricity system, Table 4 outlines the results of Powerlink's analysis into the loadshedding impacts if no augmentation occurs.

It should be emphasised that this table shows 'System Normal' loadshedding - hours of loadshedding which will occur <u>with all elements of plant in service</u>. Expected loadshedding during plant outages is indicated but not quantified. Loadshedding during outages is a 'probabilistic' calculation in that it depends on the actual load at the time of the outage. For the purposes of demonstrating relative risk implications of various scenarios, it has little relevance as it is immaterial in comparison to the expected loadshedding if system normal capability is exceeded.

TABLE 4: SYSTEM NORMAL – EXPECTED HOURS OF LOADSHEDDING.

Summer	Medium Growth & Weather	Medium Growth & Dry Year	Medium Growth & Very Hot Year	Medium Growth & Very Hot & Dry Year	Low Growth	Low Growth & Dry Year	High Growth
2000/01	0	0	N-1 shedding	N-1 shedding	0	0	6
2001/02	0	N-1 shedding	N-1 shedding	83	0	0	215
2002/03	N-1 shedding	11	61	332	0	0	643
2003/04	5	175	292	708	0	0	1179
2004/05	148	491	661	1156	N-1 shedding	N-1 shedding	2012
2005/06	441	906	1093	1825	12	234	3117

<u>Low Growth Scenario Risks</u>

From Table 4, it can be seen that the key risks if augmentation does not occur before 2004/05 (as suggested by the scenario which uses the 'low growth' forecasts) are:

- If the medium growth and average weather scenario occurs, loadshedding will occur during single contingencies in 2002/03 and 2003/04, with 5 hours of loadshedding expected in 2003/04 *under system normal conditions*.
- This rises dramatically if the medium growth scenario is combined with drought conditions or extreme temperatures. Over 170 hours of loadshedding would occur in either of these scenarios in 2003/04 *with all elements of plant in service.*

A further risk is that during the period up to augmentation, planned maintenance and refurbishment of the aged 132kV coastal system becomes very difficult. The system may be too heavily loaded for this plant to be taken out of service. This in turn increases the probability of outages and power disruptions – a risk which will increase the longer augmentation is delayed. Due to its age and location, this plant is inherently more susceptible to outages.

3.3 CONCLUSION

3.3.1. Timing Recommendation

It is Powerlink's recommendation that the Stage 2 reinforcement of the Cairns electricity system should be completed by 2002/03 at the latest.

Under the medium growth and average weather scenario outlined above, augmentation is required by the summer of 2002/03 to maintain system security and to ensure that electricity demand can be met in the event of a single fault or contingency.

The risks of delaying augmentation are considerable. There are already some risks inherent in the 2002/03 recommendation. Additional risks would be associated with delaying augmentation beyond Powerlink's timing recommendation. These have the potential to be considerable depending on relatively small changes in assumptions.

It is Powerlink's view that supply to a major international tourist destination and regional commercial hub such as Cairns should be planned prudently. If Ergon Energy, as the local electricity distribution corporation, prefers to adopt a less conservative approach to risk management (for example, undertake planning based on the lower growth scenario), Powerlink would require formal notification from Ergon stating its awareness, and acceptance, of the risks of this approach. If a change in reliability criterion is required (ie – planning on a basis other than N-1), Ergon could enter into a contractual arrangement with Powerlink as provided for in the National Electricity Code.

4.0 REVIEW OF AUGMENTATION ALTERNATIVES

4.1 BACKGROUND

In 1993, Powerlink began extensive community consultation into reinforcement of the Cairns electricity system. A final route for a 275kV transmission line between Chalumbin and Woree was approved by State Cabinet in March 1996.

The submission to Cabinet outlined the staged implementation of this project as endorsed by the Powerlink Board and FNQEB[11] in April 1996. This was as follows:

Stage 1 - Construction of 275kV line Springmount-Woree – operate at 132kV (completed June 1998).

Stage 2 - Construction of 275kV line Chalumbin-Springmount, connect to Stage 1, operate entire link at 132kV. Initially scheduled for 2001.

Stage 3 - Uprate Chalumbin-Woree line to 275kV and establish 275kV substation at Woree. Initially scheduled for 2005.

This staged approach was designed to defer capital expenditure and resulting upfront costs paid by customers. It was envisaged that the subsequent stages of the project would be implemented when required to meet power demand in the region.

4.2 REVIEW PROCESS

As outlined in section 3.0, further augmentation of the Cairns electricity system is required by the summer of 2002/03 at the latest. This is one year later than Powerlink's initial proposal for construction of Stage 2 of the Chalumbin-Woree project due to lower load growth than previously forecast.

Although Stage 2 of the Chalumbin-Woree project was previously endorsed by the Powerlink Board and agreed to in principle by FNQEB, Powerlink has undertaken a review to ensure that proceeding with the second stage of this project is still the most appropriate solution to meet the needs of Cairns customers. This is consistent with Powerlink's prudent approach to investment decisions.

As part of its review, Powerlink consulted with market participants and interested parties regarding non-transmission alternatives to provide information for its analysis of alternative approaches to transmission reinforcement of the Cairns region.

[11] Now Ergon Energy (Far North Region)

4.2.1. Requirements for Augmentations

The first step in the review was to determine the general requirements for addressing the limitations of the existing Cairns electricity system. In brief, viable options to strengthen the Cairns electricity system must satisfy six criteria if they are to meet the underlying need for augmentation:

Size: Feasible options must be large enough, individually or collectively, to meet the annual demand growth of approximately 10MW per year. Otherwise they will not solve the potential issue of demand exceeding supply capability.

Time of Year: Options must, at a minimum, be capable of meeting this demand growth during the peak summer months of November to March. The existing system is in most need of reinforcement during this summer peak, so options which do not relieve this pressure do not represent viable solutions.

Location: Non-transmission options must be located within the Cairns area. It is the Cairns area (as defined earlier in section 2.0) which is experiencing the electricity demand growth driving the need for augmentation. To be a viable solution, an option must reduce the electricity which has to be transferred into the area via the existing transmission system. This implies that any local generation option must be located within the Cairns area itself, or additional transmission augmentation will still be required to transfer its power output to electricity consumers.

Timeframe: All options must be operational before the summer of 2002/03. As outlined in section 3.3, this is Powerlink's recommended timing for reinforcement. Any deferral beyond this timeframe will adversely impact the reliability of electricity supply.

Reliability: Options must be capable of reliably delivering electricity under a range of conditions.

Certainty: Options must be committed using proven technology and have funding and project management to deliver within the required timeframe. Augmentation is critical to the reliability of electricity supply to Cairns – it is not considered appropriate to rely on uncommitted developments that may or may not proceed.

4.2.2. Consultation to Identify Non-Transmission Alternatives

Powerlink's function is to develop and operate the transmission grid to meet the needs of Queensland customers. To identify non-transmission alternatives which might be able to deliver a secure and reliable electricity supply to Cairns, Powerlink sought information from market participants and interested parties through a consultation process.

Powerlink placed public notices (Appendix 3) in Cairns and statewide newspapers. These advertisements sought to identify interested parties with information that needed to be considered in the process. In particular, Powerlink requested information on any proposals (generation or other) which might satisfy the above criteria, and which would reduce demand on the existing transmission system in the Cairns area.

In addition, Powerlink also held individual discussions with all those with a known interest in electricity supply in the Cairns region:

- Local distribution corporation, FNQEB (now Ergon Energy)
- Local electricity retailer, Ergon Energy
- Owner of Barron Gorge Power Station, Stanwell Corporation
- A selection of major customers connected to the local distribution system
- Sugar North Limited
- Bundaberg Sugar

The sugar companies are both consumers of electricity and in some cases have some co-generation capability.

Powerlink also foreshadowed the need to augment the Cairns electricity system in its ‘Annual Planning Statement’ published in March 1999, thus providing third parties with prior notice of potential opportunities for development of non-transmission solutions to meet Cairns electricity requirements.

4.2.3. Identifying Transmission Alternatives

Given the extensive community consultation undertaken by Powerlink prior to Stage 1, it is considered that the existing corridor over which Powerlink already has easements is the preferred and least cost transmission line route. Powerlink has reviewed all current technical data relevant to the Cairns region to determine whether transmission solutions other than the original staged reinforcement plan are possible on this easement. The results of this review are described in section 4.3.2.

4.3 AVAILABLE OPTIONS TO MEET CAIRNS ELECTRICITY NEEDS

4.3.1. Non- Transmission Alternatives Likely to Be Delivered by the Market

More detailed information about non-transmission alternatives provided by Code participants and interested parties during the consultation process is contained in Appendix 4.

In summary:

- No proposals for large power generation facilities in the Cairns region were put forward during the consultation process. Whilst Powerlink has been approached about grid connection for generation projects associated with the (as yet uncommitted) PNG gas pipeline project, none of these are in the Cairns region (or the required timeframe).

- Cogeneration capacity at sugar mills may be expanded in the Cairns area during the next few years. However, Powerlink has not been made aware of any firm commitments by Cairns area sugar mills to generate power outside the normal sugar crushing season prior to the 2002/03 summer. This option therefore does not meet the critical criteria of being consistently operational during summer peak demand periods.

- Other small generation options under investigation in Far North Queensland, and proposed for development during the next few years, were discussed with Powerlink. It was determined during this process that these options were either unlikely to be firmly committed to be developed prior to the summer of 2002, or alternatively were outside the Cairns area and therefore unlikely to impact the timing and need for augmentation. The recently announced wind farm on the Tablelands fits into the latter category. Energy from this generation source will be delivered into the Powerlink system outside the Cairns region. It is Powerlink's assessment that, whilst the wind farm reduces some of the future requirements on the transmission system in Far North Queensland, the impact is not significant enough to affect the required timing of the Cairns augmentation. Augmentation is therefore still required by 2002/03 to deliver the energy from this and other power sources to Cairns customers.

- Discussion of demand side management solutions also occurred. Major customers advised Powerlink that these were unlikely to be feasible in Cairns due to its tourist centre characteristics.

The conclusion of the consultation process is that the market is unlikely to deliver generation or demand side management solutions to meet the power needs of Cairns within the required timeframe.

4.3.2. Transmission Network Augmentation

Powerlink's conclusion is therefore that transmission reinforcement of Cairns is the only viable solution (in terms of size, time of operation, location and timeframe) to meet the electricity needs of Cairns.

Powerlink has investigated several variations of its previously approved Stage 2 transmission reinforcement of Cairns. Works common to all these options are as follows:

- construction of a 73km 275kV double circuit transmission line from Chalumbin to Springmount
- removal of the Springmount-Woree tee connection and reconnection of the 275kV lines to Woree to the new 275kV lines from Chalumbin
- some minor works to purchase and install capacitor banks.

The main differences between the options (full scope of works in Appendix 5) are:

Option 1 — Original Stage 2 Proposal
2002/03 - Operate both Chalumbin-Springmount line circuits at 132kV
Stage 3 - uprate both circuits to 275kV and establish 275kV substation at Woree in 2005/06

Option 2 — Modified Stage 2
2002/03 - Operate one circuit of the Chalumbin-Springmount line at 132kV, with the other circuit operated as a 275kV, 300MVA transformer-ended feeder
Stage 3 - uprate second circuit to 275kV and fully establish 275kV substation at Woree in 2005/06

Option 3 — Original Stage 2 & 3 Combined
2002/03 – Operate both Chalumbin-Springmount line circuits at 275kV and fully establish 275kV substation at Woree.

The following section outlines the results of Powerlink's analysis examining which of these options minimises the costs of providing a reliable supply to Cairns electricity consumers.

5.0 COST-EFFECTIVENESS ASSESSMENT

Powerlink is seeking to ensure that its recommended augmentation is the option that delivers the required level of reliability at the minimum overall cost to customers. As the three options outlined in 4.3.2 are a staged implementation of a single final outcome, all options provide a similar level of network performance benefits. Powerlink has therefore carried out an analysis to determine which option minimises the net present value of the overall cost of the augmentation.

5.1 CAPITAL AND OPERATING COSTS

The total estimated capital expenditure for all options to the completion of Stage 3 is approximately $50M. However, the timing of expenditure varies as follows:

TABLE 5 – CAPITAL EXPENDITURE
(1998/99 Costs - $MILLIONS):

	Option 1	Option 2	Option 3
2002/03	27.2	40.7	45.8
2003/04	1.2	1.2	
2004/05	1.2	1.2	1.2
2005/06	21.0	6.2	1.2

Note: The expenditure of $1.2M in years from 2003/04 represents the variations in timing for purchase and installation of associated capacitor banks.

This naturally has cashflow consequences for customers, with deferral of capital expenditure deferring the corresponding transmission charges paid by customers. This deferral of expenditure has been incorporated in Powerlink's Net Present Value cost analysis of the three options (see section 5.3).

Transmission charges paid by customers also include provision for operation and maintenance costs, depreciation and return on investment. An estimate of these additional costs is also included in the NPV analysis.

5.2 TRANSMISSION LOSS SAVINGS

In addition to the significant reliability and security benefits provided by augmenting the transmission system supplying Cairns, augmentation will also deliver considerable savings in transmission losses. Savings vary between the three options as outlined below, but all provide significant cost savings for customers.

Transmission losses are a function of the length and capacity of a transmission line, and the power being transferred through it. An additional transmission line reduces the amount of power that must be forced through the existing network, and therefore reduces total losses.

Powerlink has carried out extensive analysis into the market energy impacts of the network augmentation options. As the options have differing capacities between 2002/03 and 2005/06, transmission loss cost savings do differ substantially between options as shown in Table 7. All loss savings are in comparison to the situation if no augmentation occurs. These (offsetting) transmission loss savings have also been incorporated into Powerlink's NPV analysis in section 5.3.

TABLE 7 –
COST SAVINGS DUE TO REDUCTION IN TRANSMISSION LOSSES FOR VARIOUS OPTIONS ($M) - see footnote[12] for explanation of calculation method

Year	Option 1	Option 2	Option 3
02/03	0.50	1.00	1.15
03/04	1.07	2.15	2.47
04/05	1.15	2.31	2.65
05/06	1.22	2.46	2.83

*Note: As reinforcement works will occur just prior to summer, loss savings for the financial years in which reinforcement occurs are half the full year amount

Note that while cost savings due to reduced transmission losses differ in the financial year 2005/06, loss savings will be the same for all options after October 2005 when all augmentation work is complete.

5.3 RESULTS OF COST EFFECTIVENESS ASSESSMENT

Powerlink has carried out a cost-effectiveness assessment to determine the option which minimises overall augmentation costs in net present value terms. As noted above, inputs to the analysis included cashflows associated with differences in the pattern of capital costs, operating costs and the different cost savings due to reductions in transmission losses.

Cashflow analysis has been carried out for the period until 2005/06 after which all three options are identical. As stated in 4.3.2, all options involve the completion of initial augmentation works in the summer of 2002/03. Results of the Net Present Value Cost analysis, including sensitivity to varying discount rates, are shown in Table 8.

TABLE 8: NET PRESENT VALUE COST OF OPTIONS

Discount Rate	Option 1	Option 2	Option 3
6%	$8.8M	$9.1M	$9.2M
8%	$8.4M	$8.7M	$8.8M
12%	$7.6M	$8.0M	$8.2M

[12] These loss savings are based on analysis which aims to predict the value of actual energy losses with and without the transmission augmentation. A simulation was run for a full 12-month period to determine energy payments to and from the electricity market pool. The simulation used historical spot prices, adjusted downwards to account for the expected low cost generation from the new Callide and Millmerran Power Stations. These forecast half-hourly energy prices were then applied to the expected energy usage in the Cairns area, allowing for losses during transmission. These studies were carried out with and without the proposed augmentation, with the difference being the quantified loss saving dollar benefit due to the transmission augmentation. Powerlink considers this approach provides a more accurate result than either using an average pool price (average losses) method or calculation of loss saving benefits resulting from changes in marginal loss factors.

It should be noted that the costs in Table 8 represent the cost of augmenting the system at a timing that ensures N-1 reliability criteria can continue to be met under the most probable range of system conditions. However, the appropriate balance between commercial and reliability considerations is, in the end, a customer choice. Powerlink is prepared to work to reliability criteria below N-1 should it be requested by Ergon Energy to do so, provided that Ergon formally accepts the risks inherent in such a decision and indemnifies Powerlink accordingly.

5.3.1. Other Issues for Consideration in Option Decision

It is Powerlink's view that, of the three options, Option 2 is likely to provide the best outcome for customers. Option 2 has benefits in addition to delivering a level of network performance consistent with meeting reliability obligations. These additional benefits result from the partial early establishment of Woree substation, and are therefore not available with Option 1[13]. Examples of these include:

- Option 2 (partially establishing Woree in 2002/03) is a higher capacity solution. The transmission system may be able to carry larger volumes of power to Cairns during contingencies, depending on the nature and location of the most critical contingency.
- Option 2 allows Powerlink to implement an alternative solution to the need for greater transformer capacity at Gin Gin. The timing would allow transformers at Chalumbin and Gin Gin to be refurbished and swapped. It is estimated that this would have a net present value benefit to Ergon Energy of $1.6M over the purchase of new 200MVA transformers for Gin Gin.
- Powerlink's program of coastal asset replacement and refurbishment can be carried out at a reduced level of risk during contingencies.

The differences in net present value costs of the options (which are all variations in timing of the same ultimate solution) are not significant, within the accuracy of the estimates. However, because of the additional advantages, Option 2 is Powerlink's recommendation.

[13] Note that Option 3 also delivers the same additional benefits. However, as Option 3 involves higher upfront capital expenditure for the same net present value cost, Powerlink is recommending Option 2 in preference to Option 3.

6.0 DECISION TIMEFRAME

To meet the requirement for the Stage 2 reinforcement to be in place by late 2002, the following program is necessary:

Recommendation finalised	February 2000
Ratification by Powerlink Board	February 2000
Design, procurement etc	from April 2000
Construction	from March 2001
Testing & Commissioning	from June 2002
Project Complete	September 2002

The recommendation to proceed must therefore be finalised by February 2000.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Powerlink's recommendations as contained in this report are:

(1) Augmentation of the Cairns electricity system should occur before the summer of 2002/03 at the latest to ensure reliability and security of supply can be maintained.

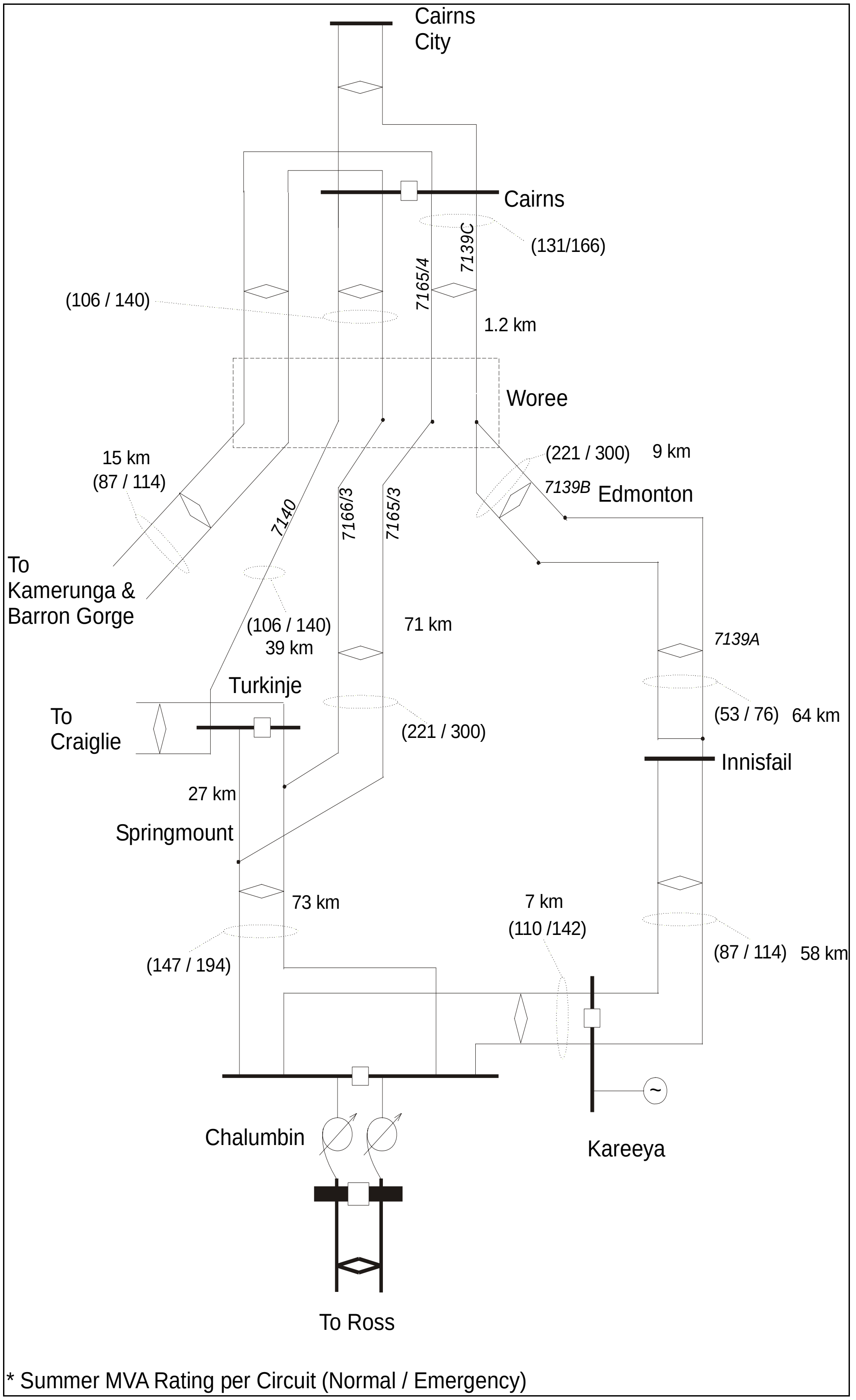
This timing ensures that Powerlink can supply all electricity demand in the Cairns region during single contingencies (based on a scenario incorporating typical summer weather, forecast electricity demand which follows the historical trend and average support from Barron Gorge hydroelectric power station).

Powerlink considers that this timing recommendation is a prudent approach to planning supply for a major international tourist destination and regional commercial hub such as Cairns.

(2) A modified version of Powerlink's initial Stage 2 Chalumbin-Woree project should be implemented. This option includes construction of a 275kV line between Chalumbin and Springmount, operation of one circuit of the completed link between Chalumbin and Woree at 132kV and the other circuit at 275kV.

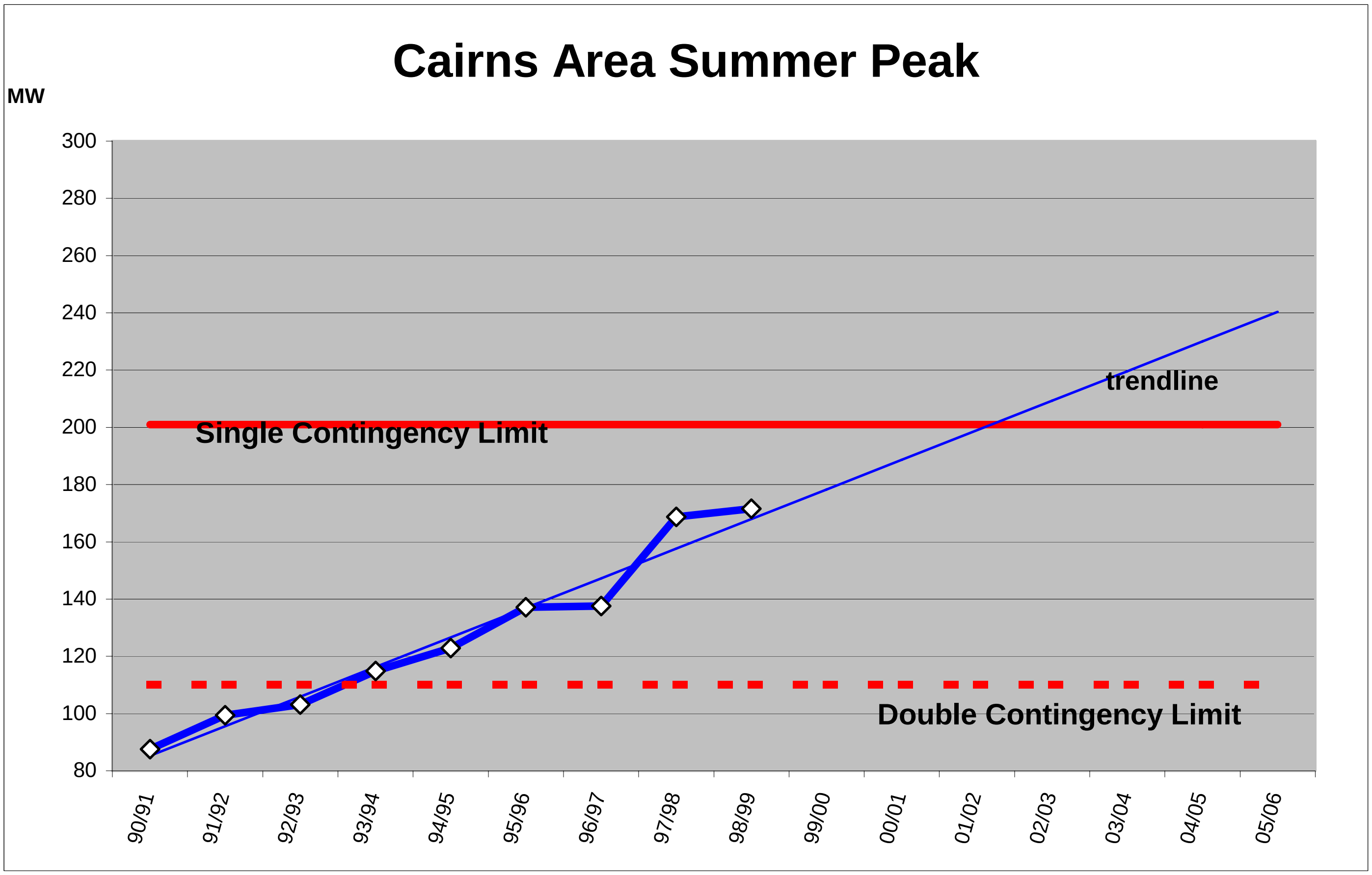
This option has a capital cost of approximately $44 million. Its main purpose is to ensure supply to Cairns customers meets security and reliability criteria, but it also results in significant transmission loss savings of approximately $2.0-2.5M per annum. This option is recommended because it delivers additional benefits in comparison to other transmission options investigated, for a similar net present value cost.

APPENDIX 1 – Existing Transmission System into Cairns



* Summer MVA Rating per Circuit (Normal / Emergency)

APPENDIX 2 – Actual Demand Compared with Historical Trend



APPENDIX 3 –

REVIEW OF ELECTRICITY FORECASTS – CAIRNS REGION

Powerlink QUEENSLAND ®

As an integral part of its network planning, Powerlink is currently reviewing its electricity demand forecasts and analysis related to the transmission of electricity into Cairns beyond 2001.

Powerlink is therefore interested in hearing from both developers of future power generation facilities in the Cairns region, and developers of any programs designed to reduce electricity demand in the region.

Developments meeting the following criteria could impact forecasts and the timing of any required augmentation of electricity supply:

- Operational by late 2001
- Generate or save at least 5MW of power
- Reduce demand on the transmission system supplying the Powerlink substations at Turkinje (near Mareeba), Hartley Street (Cairns) and Kamerunga (Cairns), and the FNQEB substation at Cairns City. This is expected to limit relevant developments to the geographic area north of a line from Atherton to Babinda and east of a line from Atherton to Mareeba and Mossman.

Please write or fax in the first instance providing details of project scope, location & timeframe to:
Network Business
Powerlink Queensland
GPO Box 1193
Virginia QLD 4014
Fax: (07) 3860 2388

TMP K97728

Closing date for responses: Friday 20th November, 1998.
For enquiries, telephone Alison Gray on (07) 3860 2300.

Powerlink Queensland is the trading name of the Queensland Electricity Transmission Corporation Limited ACN 078 849 233

* Advertisement published in The Cairns Post and The Courier Mail 7/11/98

APPENDIX 4 –

CONSULTATION OUTCOMES - NON-TRANSMISSION ALTERNATIVES

Submissions / Information from Consultation

As a result of the consultation, several parties came forward to discuss potential generation developments in the Cairns region. However, because of the commercial sensitivities of many new generation proposals, Powerlink Queensland is restricted in its ability to disclose information. Some information was provided for planning purposes on the proviso that the company and proposed generation project not be publicly identified.

In summary, Powerlink held discussions related to the following proposals:

- Additional cogeneration at sugar mills. Several mills in North Queensland have installed cogeneration facilities to generate electricity during the sugar crushing season. Feasibility of additional plants is being investigated

- Unidentified power generation proposals. Powerlink was provided with load profiles (expected generation capacity on a monthly basis) for several future generation initiatives under investigation.

- Developments based on renewable fuel sources. Powerlink was advised of studies into fuel sources such as forestry and rubbish tip waste in the Cairns region. No specific project was submitted for discussion.

- Powerlink raised the potential for demand-side management initiatives during meetings with the local retailer and major customers. In addition, a representative of a company producing power factor correction equipment spoke to Powerlink about the potential for this equipment to increase the efficiency of electric motors at customer premises.

A discussion of specific submissions and implications for electricity supply to Cairns follows. However, the overall conclusion of the consultation process is that the market is unlikely to deliver generation or demand side management solutions to meet the power needs of Cairns within the required timeframe.

Large Scale Generation

Powerlink received no information during the consultation process about potential large generation projects in the Cairns area.

Powerlink is aware of media reports and public discussion of the potential fuel source provided by the proposed gas pipeline from New Guinea. Powerlink has also been approached separately about grid connection for generation projects associated with this (as yet uncommitted) pipeline project. Powerlink is unaware of any specific proposals to utilise this fuel in a generation project in the Cairns area in the required timeframe.

Should a decision to proceed with the pipeline project be made in the near future, it is highly unlikely that the lead times of the project would allow power generation in Cairns in the next 3 years. Earliest dates in media reports indicate the pipeline, if it proceeds, could be operational by 2003. As such, it is considered unlikely that the pipeline could be built, and a large generation project established in the Cairns area prior to the time augmentation is required in 2002/03.

Powerlink considers it would not be prudent to depend on generation reliant on gas from New Guinea given the timing requirement and the project uncertainty. The risk to Cairns electricity supply of delaying augmentation would be high (as outlined in 3.2). As such, large generation is not a feasible alternative to immediate network augmentation. However, it should be noted that proceeding with network augmentation does not preclude future generation development in Cairns based on gas or other fuel sources. In fact, further network augmentation could potentially advantage a large-scale generation development in the area as increased transfer of power output to electricity consumers south of Cairns would be possible.

7.1.1. <u>Small Scale Generation</u>

This option involves the establishment of local generation developments in the Cairns area prior to 2002/03. As stated previously, it is essential such options are large enough to meet the annual demand growth of approximately 10MW per year.

It is also critical that they operate during the peak summer months of November to March. The existing system is in most need of reinforcement during this summer peak, so options that do not relieve this pressure are not viable solutions.

During the consultation process, discussions regarding potential development of cogeneration plants at sugar mills were held with Sugar North Limited and Bundaberg Sugar. These two organisations together represent all sugar mills in the Cairns region.

Information provided to Powerlink indicated that some possibilities do exist for expansion of existing cogeneration plants in the immediate Cairns area. Provided they operate during the peak summer period, these options may collectively be of a sufficient power export capacity to defer transmission augmentation. However, Powerlink has been advised that:

- no firm commitments have been made to proceed with expansion proposals
- export power capability of the sugar mills during the summer period will be limited.

The peak summer demand period from November-March is outside the sugar cane crushing season. Investigations are underway into issues such as bagasse availability and storage and alternative fuel sources to allow post crushing season operation. However, Powerlink has been advised that consistent cogeneration during the summer period which is of a sufficient size to meet the annual load growth of Cairns load growth is unlikely to be available prior to the summer of 2002/03. There may be potential for such development in the future.

Through the consultation process, Powerlink was also provided with load profiles showing expected generation capacity on a monthly basis of several unidentified small power generation proposals (7-25MW) under investigation in north Queensland. Only one of these had the potential to be operational during the peak November to March summer period prior to the summer of 2002/03. However, it was determined that this development was out of the immediate Cairns area and Powerlink's analysis shows that it would therefore not be able to contribute significantly to reducing the demand on the transmission system supplying Cairns.

These proposals therefore did not meet the base-level criteria which would allow them to be viable alternatives to network augmentation in Cairns.

7.1.2. Demand-Side Management Initiatives

During the consultation process, Powerlink also requested to be advised of potential demand side management (DSM) initiatives that could reduce demand on the electricity system supplying Cairns.

Some industry participants expressed interest in proposing DSM options which could be available for up to about five hours per day. The type of DSM option discussed would involve customers agreeing to have their power supply interrupted for a continuous period of up to five hours, for some compensation in the form of lower electricity tariffs.

Powerlink has determined that to achieve a one-year deferral of transmission augmentation (10MW), such options would have to be available for up to ten hours each summer weekday from about 9am to about 7pm. This is the period when prolonged summer demands can be experienced. That is, for a demand side response of up to five hours, a total of about 20 MW of capacity would be needed, cycled in two 10 MW blocks throughout the day. This is equivalent to about 10% of the 2002/03 peak electricity demand of Cairns (210MW) agreeing to voluntarily do without electricity for a period of five hours each summer weekday in the event of a contingency on the electricity system.

Discussions with a number of major FNQEB customers identified that larger power users in Cairns are primarily shopping centres, hotels and other facilities catering to tourism. In this non-manufacturing environment, these major electricity users considered that such DSM was not feasible. Reductions in electricity tariffs would be unlikely to compensate for the potential loss of business.

Another initiative was put forward to Powerlink by a company which produces power factor correction equipment for electric motors. This type of equipment has some technical benefits, but Powerlink considers that installing such equipment in the Cairns region would not have a significant impact on the Cairns area demand which must be met by the transmission system.

DSM technology is immature as an option, and will take time to develop. Even so, there is limited capability for such initiatives in the Cairns region. The option of deferral of other augmentation options purely through DSM is not considered achievable. DSM initiatives may, however, be developed over time and work in conjunction to increase the length of time before further system augmentation is required.

APPENDIX 5 –

SCOPE OF OPTIONS FOR CAIRNS REINFORCEMENT

1.1 SCOPE OF OPTION 1

The proposed works are illustrated in Figure 1 and are described below:

- Construct from Chalumbin to Springmount, approximately 73 km of 275 kV high reliability double circuit line consistent with circuits used as major interconnectors, using twin "Phosphorus" or equivalent conductor;

- Remove the Springmount-Woree Tee connection at Springmount and reconnect the 275 kV lines to Woree to the new 275 kV lines from Chalumbin;

- Add two 132 kV line bays at Chalumbin and connect to the Chalumbin-Woree circuits;

- Substation protection and control;

- Line protection and control modifications and additions, including high speed auto-reclose – assume Chalumbin MASTER END with synch check at Cairns.

1.2 SCOPE OF OPTION 2

The proposed works are illustrated in Figure 2 and are described below:

- Construct from Chalumbin to Springmount, approximately 73 km of 275 kV high reliability double circuit line consistent with circuits used as major interconnectors, using twin "Phosphorus" or equivalent conductor;

- Remove the Springmount-Woree Tee connection at Springmount and reconnect the 275 kV lines to Woree to the new 275 kV lines from Chalumbin;

- Add one 132 kV line bay at Chalumbin and connect to one of the Chalumbin-Woree circuits;

- Add one 275 kV circuit breaker and buswork at Chalumbin, and connect the other Chalumbin-Woree circuit;

- Purchase and install at Woree, one 300 MVA, 275/132 kV auto-transformer, complete with tertiary winding and on load tap changer – connect as "transformer ended feeder";

- Purchase and install at Woree, one 24 MVAr, 300 kV switched line reactor;

- Establish the Woree Substation with 132kV bus, one bus section circuit breaker, four line 132 kV circuit breakers and 132kV transformer circuit breaker, and connect the new transformer, the Innisfail circuit and circuits to Cairns;

- Modify and augment substation protection and control;

- Line protection and control modifications and additions, including high speed auto-reclose – assume Chalumbin MASTER END with synch check at Cairns/Woree.

1.3 SCOPE OF OPTION 3

The proposed works are illustrated in Figure 3 and are described below:

- Construct from Chalumbin to Springmount, approximately 73 km of 275 kV high reliability double circuit line consistent with circuits used as major interconnectors, using twin “Phosphorus” or equivalent conductor;

- Remove the Springmount-Woree Tee connection at Springmount and reconnect the 275 kV lines to Woree to the new 275 kV lines from Chalumbin;

- Add three 275 kV circuit breakers and buswork at Chalumbin to form a “six switch mesh” arrangement;

- Purchase and install at Woree, two 300 MVA, 275/132 kV auto-transformers, complete with tertiary windings and on load tap changers – connect as “transformer ended feeders”;

- Purchase and install at Woree, two 24 MVAr, 300 kV switched line reactors;

- Establish Woree 275/132kV Substation 132 kV circuit breakers and buswork, to connect the two new transformers, the Innisfail circuit, the Turkinje circuit (until its removal after the rebuild of Innisfail to Edmonton 132 kV) and four circuits to Cairns;

- Modify and augment substation protection and control;

- Line protection and control modifications and additions, including high speed auto-reclose – assume Chalumbin MASTER END with synch check at Woree for both circuits.

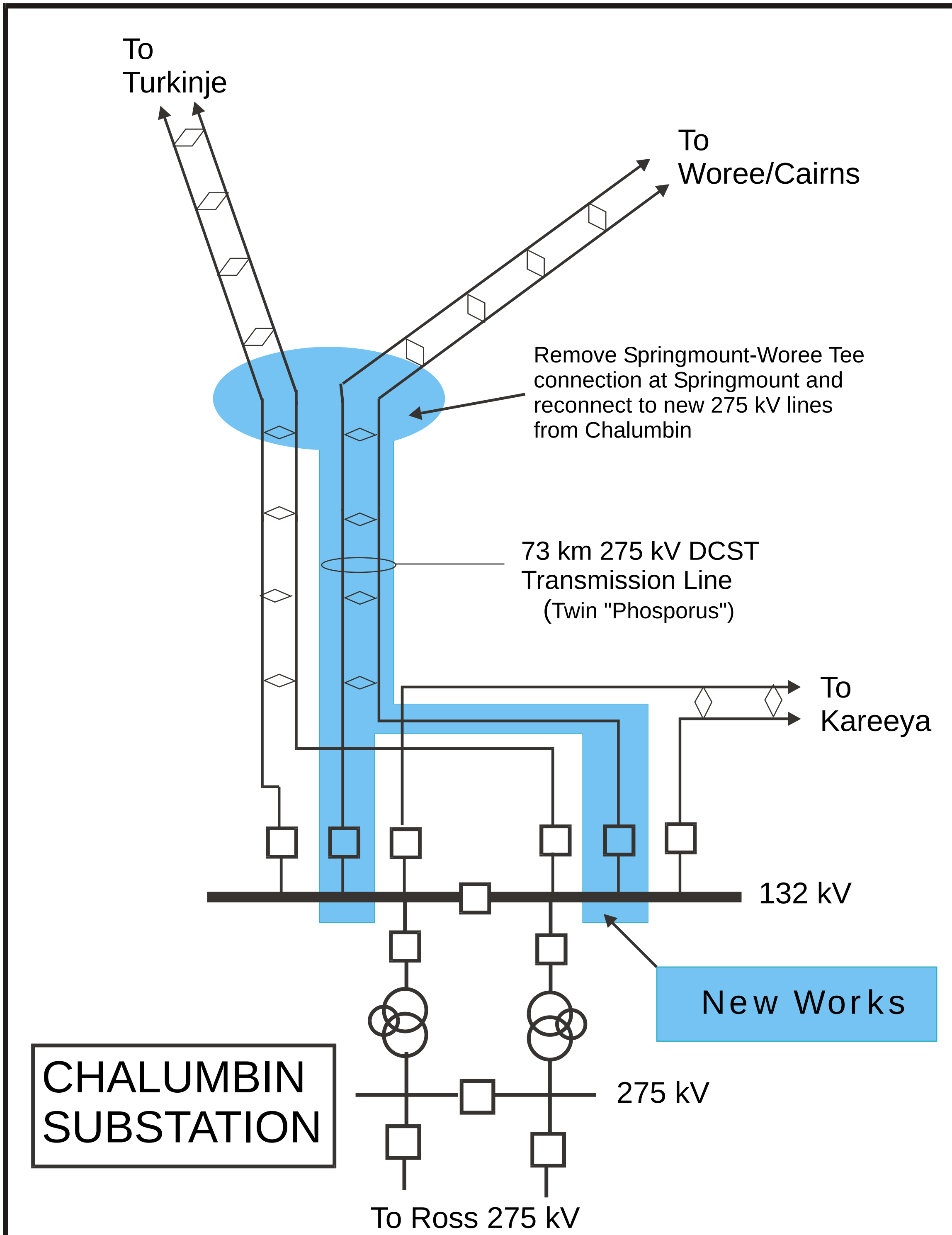


FIGURE 1 : PROJECT 707 OPTION 1

CHALUMBIN-SPRINGMOUNT
275 kV TRANSMISSION LINE

Project 707

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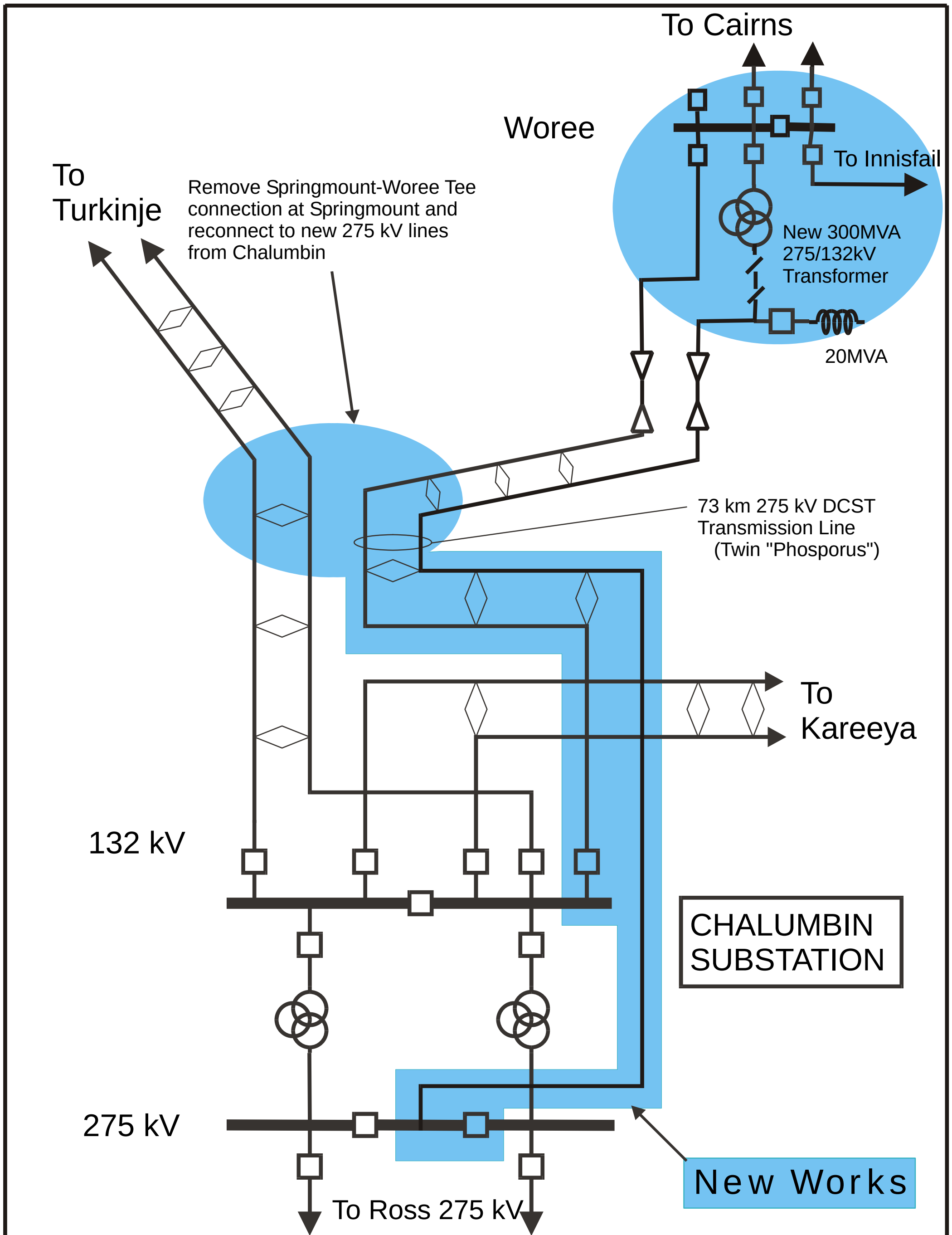

FIGURE 2 : PROJECT 707 OPTION 2

CHALUMBIN-SPRINGMOUNT
275 kV TRANSMISSION LINE

Project : 707

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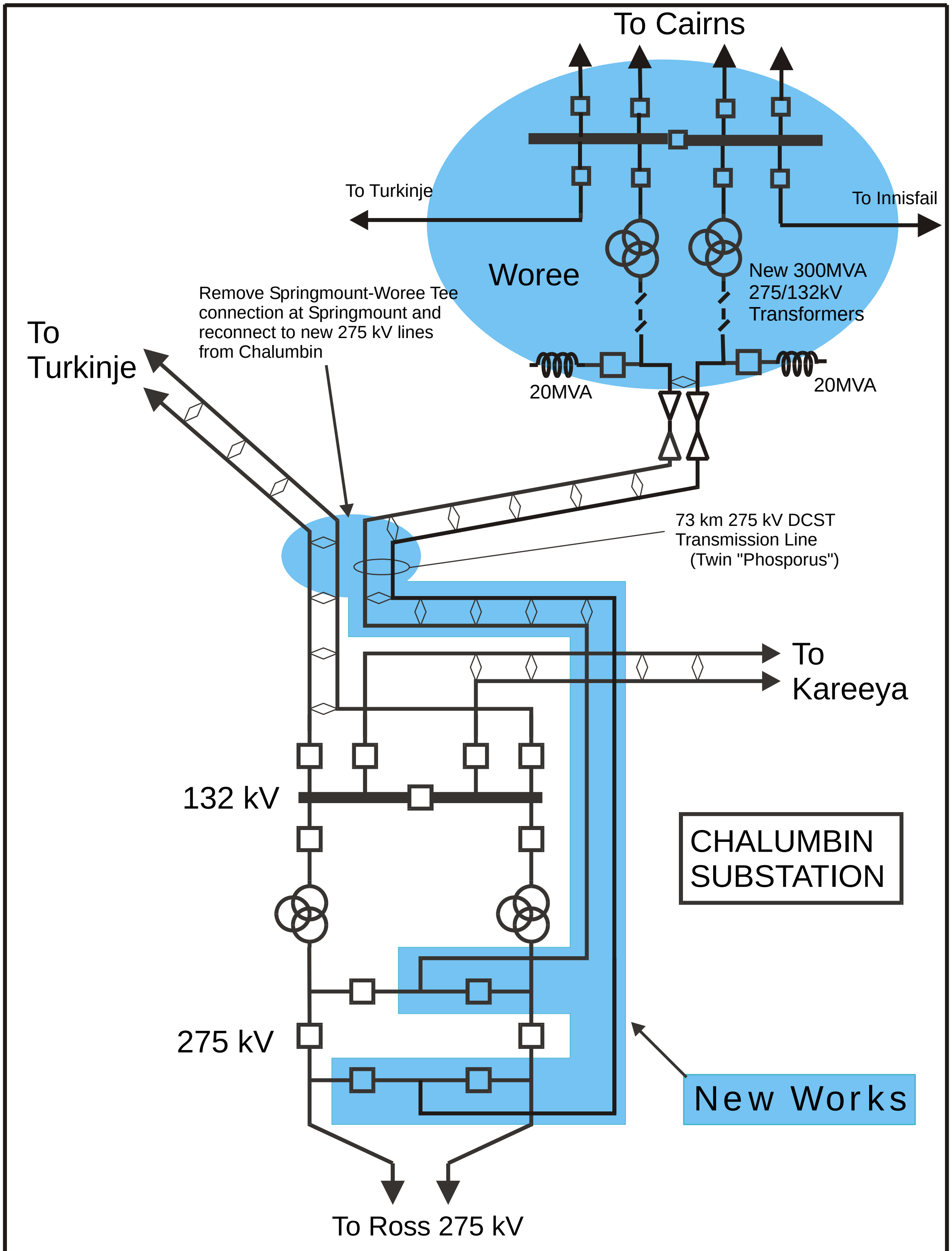

FIGURE 3 : PROJECT 707 OPTION 3

CHALUMBIN-SPRINGMOUNT 275 kV TRANSMISSION LINE

Project : 707

File : 1/230/707

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23 September 1999